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IMPLEMENTATION OF THE INSPECTION WORKSTATION CONTROLLER

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Certain commercial equipment, instruments, or materials are identified in this paper in order to adequately specify the experimental procedure. Such identification does not imply recommendation or endorsement by the National Bureau of Standards, nor does it imply that the materials or equipment identified are necessarily the best available for the purpose.

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IMPLEMENTATION OF THE INSPECTION WORKSTATION CONTROLLER

I. INTRODUCTION

1. WHAT THIS DOCUMENT IS ABOUT

This document describes the implementation specifics of the Inspection Workstation Controller (WSC) program. This program runs under the control of the ECS program that is described in the document IMPLEMENTATION OF THE EXECUTION CONTROL SYSTEM OF THE INSPECTION WORKSTATION. The controller program consists of state machine modules that "customize" the controller for its particular application -- i.e. supervising the IWS.

2. AUDIENCE

Anyone who needs to understand the internals of the WSC software should read this document. This includes anyone who will continue the development of the WSC software or make modifications to it.

The document ARCHITECTURE AND PRINCIPLES OF THE INSPECTION WORKSTATION describes the principles that the ecs and WSC programs utilize. It is recommended that this document be read first.

3. OVERVIEW

Chapter II gives a top level description of the WSC. It specifies the location of the WSC in the IWS control hierarchy, and describes the main functions the controller performs.

Chapter III discusses some of the principles used in the design of the WSC.

Next, Chapter IV describes the main data structures, both global to the AMRF as well as local to the IWS, that the controller program uses. The specific task decomposition that the WSC incorporates is explained next in Chapter V. Additionally, procedure modules used by the main tasks discussed in Chapter V are described in Chapter VI.

The actual interface to the equipment controllers that the WSC supervises is specified in Chapter VII. Specific details used in the start up and shut down procedures are described in Chapter VIII. Errors that can occur during operation are listed and explained in Chapter IX. Chapter X describes the user interface to the WSC. Finally, Chapter XI discusses future development plans for the WSC.

The appendices include further information and implementation details. Appendix A lists the entire IWS documentation set. In Appendix B is the list of references. Appendix C contains a glossary of terms used in this document. Appendix D specifies the local data files used by the WSC.

Completing the document is a reader/comment form. You are encouraged to write down your comments and mail the attached form to the address specified.

II. HIGH LEVEL DESCRIPTION OF THE WORKSTATION CONTROLLER

1. BRIEF DESCRIPTION

The Inspection Workstation Controller supervises the equipment controllers of the Inspection Workstation. The controller uses a data driven, hierarchical task decomposition control strategy and incorporates the University of Virginia (UVA) model for system initialization, restart, and shutdown [B.1].

2. LOCATION IN THE WORKSTATION ARCHITECTURE

As shown in Figure 1, the WSC is subordinate to the Cell Controller and manages the operation of the Inspection Robot and Coordinate Measuring Machine Controllers.

3. MAIN CONTROLLER FUNCTIONS

The overall function of the WSC is to interface with the Cell controller, to schedule equipment tasks, and to regulate the activity of the workstation equipment controllers.

4. WORK ELEMENTS AND STATUSES

The WSC receives commands from the Cell Controller. As stipulated in the AMRF architecture and UVA system model specifications, these commands are either transition or work order commands [B.2]. The WSC receives the standard transition commands and issues the standard status responses. The work order commands supported by the WSC are RECEIVE TRAY, INSPECT LOT, and SHIP TRAY.

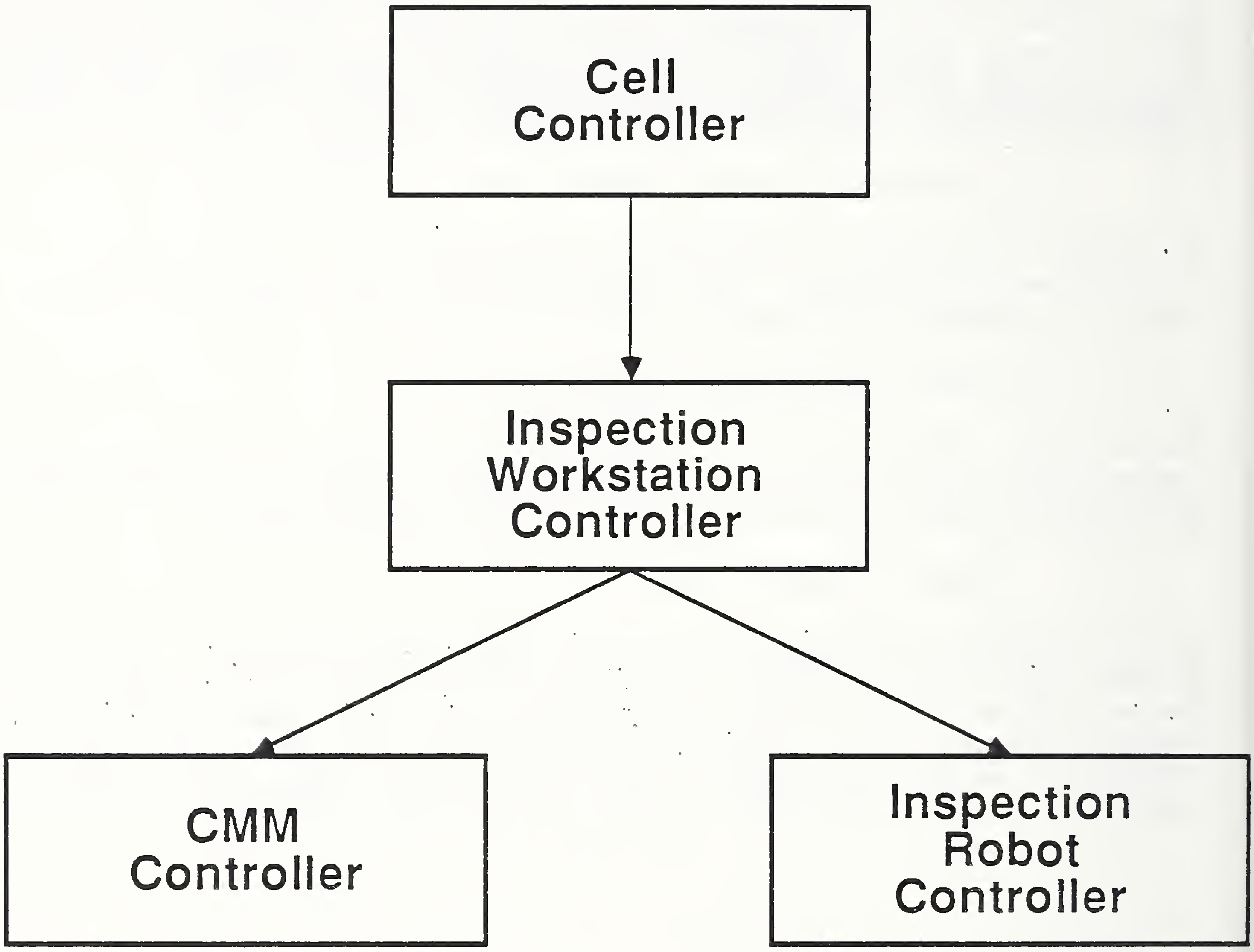

Figure 1: Logical Configuration of the Inspection Workstation Controller

III. SPECIFIC WORKSTATION CONTROLLER DETAILS

1. WORKSTATION CONTROLLER FUNCTIONS

1.1. Cell Controller Interface

The Cell to Inspection Workstation interface entails decoding command data, parsing and managing commands, and reporting command statuses. Interfacing with the Cell Controller is performed by the Workstation Manager module of the Workstation Controller. The implementation of the Workstation Manager is detailed in a following section.

1.2. Task Scheduling

Task scheduling is a requisite responsibility for controllers which use a hierarchical control strategy and are in charge of managing a number of tasks which are dependent on shared resources. The present Inspection Workstation configuration consists of a Coordinate Measuring Machine used to measure the dimensional tolerances of a part, a Surface Roughness Instrument used to measure a part's surface finish, and a robot used to transfer parts from the tray to either of the measuring machines or from one of the machines to the other. Task scheduling at the IWS involves coordinating the inspection processes of the CMM and SRI with the transfer of parts by the robot. Pertinent data is retrieved from the AMRF database by the Production Manager module and the Queue Manager module performs the required task scheduling.

1.3. Equipment Controller Interface

The Workstation Controller interfaces with the equipment controllers through individual equipment Dispatcher modules. The implementation of the Dispatchers is detailed in a following section.

2. WORKSTATION CONTROL STRATEGY

2.1. Task Decomposition Using Hierarchical Control

The WSC uses the hierarchical control strategy for task decomposition [B.3]. The input task to the Inspection Workstation Controller is a Cell Controller work order, such as INSPECT LOT, and the output is a set of high level work elements to the equipment controllers, such as INSPECT PART for the Coordinate Measuring Machine Controller and TRANSFER for the Robot Controller. These work elements constitute the process plan for the inspection procedure. Consistent with the hierarchical control philosophy, each level of the WSC hierarchy is in charge

of decomposing the input command into a simpler form and when appropriate, issuing new tasks to the lower levels of control. Also, each module is subject to reporting the status of the input command and supervising the operation of the next lower control level [B.4].

2.2. State Transition Using The UVA System Model

The UVA system model is used to specify the WSC state transition processes. As defined in the UVA system model document, there are three quiescent states and six non-quiescent states. The quiescent states are COLD SHUTDOWN, WARM SHUTDOWN, and READY and the non-quiescent states are BUSY COLD STARTUP, BUSY WARM STARTUP, BUSY COLD SHUTDOWN, RECONFIGURATION, BUSY CHANGE CONTROL MODE, and BUSY CHANGE DATA MODE. At the moment only the quiescent and the first three non-quiescent states have been implemented in the WSC.

The following states were added in the WSC to the basic UVA system model explained above in order to account for a more varied operation : BUSY INITIALIZE, SYNCHRONIZE WAIT, BUSY SYNCHRONIZE, IDLE, and BUSY PROCESS. The first three states can be considered to be sub-states of the BUSY COLD STARTUP state and the last two to be sub-states of the READY state.

The WSC modules power up into the BUSY INITIALIZE state where system initialization is performed. Subsequently, the SYNCHRONIZE WAIT state is entered wherein a SYNCHRONIZE command is expected in order to transit to the BUSY SYNCHRONIZE state. In the BUSY SYNCHRONIZE, the WSC waits for a response of DONE from lower level module before entering the WARM SHUTDOWN state.

READY is the state the WSC modules are in while expecting either work orders or a WARM SHUTDOWN command. The BUSY PROCESS and IDLE sub-states are used to distinguish between working and not working on a work order in READY state. This differs from the BUSY WARM SHUTDOWN processing of work orders where no sub-states are needed since no new commands are accepted until warm shutdown is completed.

2.3. Data Driven Processes

The control processes of the Inspection Workstation Controller are data driven. Data driven process control implies that the while the structure of the program is fixed, the output control commands are dependent on the input data. In the WSC, there are three variable data entities: the tray definition report, the tray contents report, and the inspection process plan. The WSC uses the tray contents report and the inspection process plan to decompose the input work order command of INSPECT_LOT into the scheduled set of equipment level work orders.

IV. DATA STRUCTURES

1. AMRF DATA

As stated above, the Workstation Controller uses three data reports to prepare, schedule, and perform the inspection process. The three reports are the Tray Definition, Tray Contents, and the Process Plan reports. They are discussed in more detail later. Data stored in the AMRF database is in a format which has been specified in the Control-Database Interface document [B.5].

To access the data from the AMRF database, the WSC uses a Data Server module which interacts with the Integrated Manufacturing Data Administration System (IMDAS) [B.6]. The Data Server accepts requests from the WSC, encodes them in the a form understood by the IMDAS, monitors the status from the IMDAS, and then decodes the responses back into a form understood by the WSC. Currently, only the WSC makes use of the Data Server; however, this module can be accessed by any of the Inspection Workstation Controllers.

1.1. Tray Definition

As specified by the Control-Database Interface document, the Tray Definition report is used to create or obtain an attribute description of a tray type. This report defines the tray sectors and their position and size within the tray.

1.2. Tray Contents

The Tray Contents report is specifies the item serial number of the part in each of the tray sectors defined in the Tray Definition report and their position relative the sector origin.

1.3. Inspection Process Plan

The Inspection Process Plan report provides information about the specific inspection steps with given precedence relations [B.7]. The inspection steps include instructions to the Coordinate Measuring Machine to load data and to inspect a part, and to the Inspection Robot to transfer parts, to load the Surface Roughness Instrument data, and to inspect a part with the SRI.

2. INTERNAL DATA STRUCTURE

Using the three reports mentioned above, the WSC creates an internal operation list data structure which maintains a view of the Inspection Workstation processes. This data structure is updated as the operation proceeds in order to preserve the IWS world model.

V. TASK DECOMPOSITION

1. WORKSTATION MANAGER (WSM)

The Workstation Manager module is the topmost layer of the WSC hierarchy and serves as the communications administrator between the Cell and the rest of the Inspection Workstation Controllers (See Figure 2). Its functions include receiving and managing cell commands, reporting the IWS status back to the cell controller, and monitoring the operation of the Production Manager Module. The Inspection Workstation Controller utilizes the standard AMRF command data communication protocol to interface with the Cell Controller.

Upon receiving a cell command, the WSM first decodes it into the local data structure. The WSM then looks at the input command and depending on the current state, takes appropriate action if possible. As specified in the AMRF architecture document, there are two types of commands sent by the cell controller: transition commands and work orders. Only one or the other is permitted per cell command. Since the Workstation Manager filters the cell commands, commands are strictly regulated between the lower levels which greatly reduces the complexity of the control strategy.

A transition command causes the WSM to change to a non-quiescent state pending a response from the lower level. However, if the current state is READY and a WARM SHUTDOWN command is received, then the WSM will transit to BUSY WARM SHUTDOWN state but will continue to process all of the work orders in the queue before issuing the WARM SHUTDOWN command to the lower level. The WSM does not accept commands while in a non-quiescent state.

As specified in the UVA system model, the WSM only processes work orders if it is in the READY state. Also, in the current implementation only one work order is allowed per cell command. The Inspection Workstation accepts three work orders: RECEIVE TRAY, INSPECT LOT, and SHIP TRAY. In the current configuration of only one tray table, both the RECEIVE TRAY and SHIP TRAY orders are redundant since the information contained in them is duplicated in the INSPECT LOT order.

The INSPECT LOT work order is a high level command directing the WSC to inspect a tray of parts. The order includes data about the tray type, the tray identification number, and the inspection process plan name for the given tray of parts. Consequently, the WSM issues an EXECUTE command to the Production Manager module along with the above data as arguments. The WSM then changes state from READY/IDLE to READY/BUSY PROCESS and stays in this state until the Production Manager responds with a DONE status.

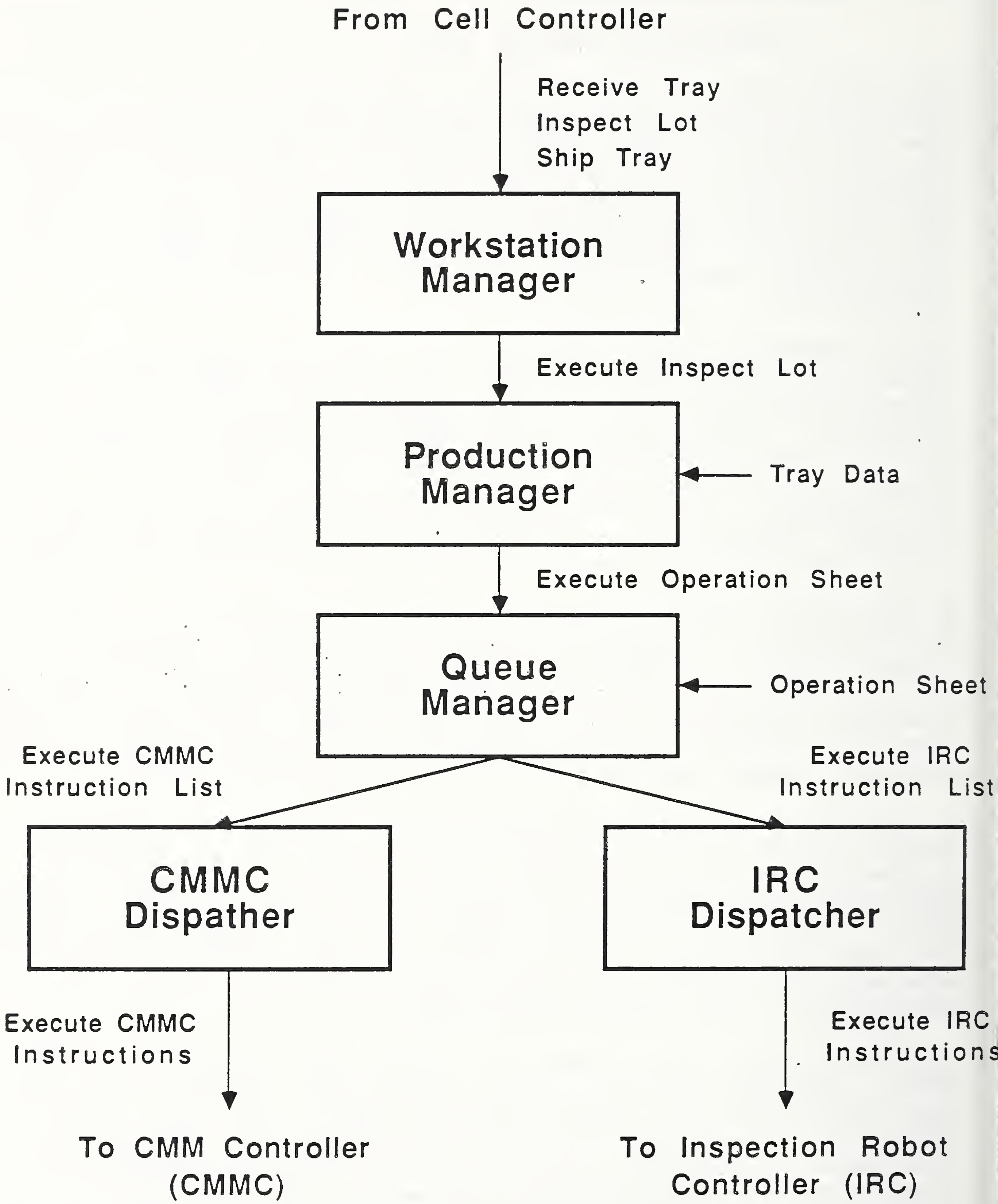

Figure 2: Task Decomposition for the Inspection Workstation Controller

2. PRODUCTION MANAGER (PMGR)

The Production Manager's primary responsibility is to coordinate the inspection process. The PMGR receives from the Workstation Manager module a command to EXECUTE along with the necessary tray and part identification information. With this information, the PMGR retrieves the tray definition, tray contents, and process plan reports from the IMDAS and generates the overall equipment task queue [B.8].

The task list is constructed by parsing the process plan report which is developed offline using the interactive Computer Aided Process Planning System of the AMRF. For the present workstation organization of a Coordinate Measuring Machine (CMM) and a Surface Roughness Instrument (SRI) under the control of the Inspection Workstation Robot, the task list contains commands to the CMM to inspect a part, to the robot to transfer parts, and to the robot to inspect a part with the SRI. After the task list is made, the PMGR issues an EXECUTE command to the next module and a pointer to the overall workstation task list.

3. QUEUE MANAGER (QMGR)

The function of the Queue Manager is to set up and supervise the operation of each of the equipment dispatcher modules. Upon receiving the command to EXECUTE from the Production Manager, the QMGR goes through the overall task list and generates the individual equipment task lists while preserving the task order and the starting precedence of the process plan. The QMGR then sends an EXECUTE command and a pointer to the appropriate task list to each of the dispatcher modules and awaits a response of DONE which indicates the completion of all of the tasks in the equipment task list.

An important job carried out by the QMGR is to detect equipment deadlock. Deadlock is the condition where the start of a machine's pending assignments are predicated on the completion of another machine's task whose start is also blocked. The QMGR receives three statuses from each of the equipment dispatchers: DONE, WORKING, and BLOCKED. DONE indicates an idle state with no pending tasks, WORKING signifies busy processing the task list, and BLOCKED marks an idle state with an impeded pending task. Deadlock occurs when all equipment dispatchers are reporting BLOCKED. In the current implementation, this condition is considered an error and deadlock resolution is not attempted.

4. EQUIPMENT DISPATCHERS

There is one Dispatcher module for each equipment controller. Each Dispatcher is responsible for deciding the next equipment task in the list to be performed, sending back operation status to the Queue Manager module, issuing commands to the equipment controllers, and monitoring the status of the equipment controllers.

In a Dispatcher module, there are three sub-states of the READY state: IDLE, BUSY PROCESS, and BLOCKED. The READY/IDLE state indicates that the Dispatcher is ready to receive inspection commands but has not yet received the EXECUTE order to begin processing its specific equipment task list. After receiving the EXECUTE command, the Dispatcher module reports back WORKING to the Queue Manager module and then goes into the BUSY PROCESS sub-state.

In the BUSY PROCESS state, the Equipment Dispatcher module attempts to complete its assigned tasks by going through its task list trying to find an available task. A task is available if it has not yet been processed and all of its preceding tasks have been completed. If a task is free the Dispatcher issues the command to the equipment controller and waits for it to respond with a DONE status. After the Dispatcher receives a DONE status from the equipment controller it again tries to find a new task to work on.

On the other hand, if a task is not available, the Dispatcher reports back to the Queue Manager a status of BLOCKED and enters a BLOCKED state. In the BLOCKED state, the Dispatcher continually checks its task list to see if a task has opened up. When that task becomes available, the Dispatcher reports back WORKING to the Queue Manager and returns to a BUSY PROCESS state.

After the Dispatcher has completed all of the tasks in its equipment task list, it reports back a DONE status to the Queue Manager and enters the READY/IDLE state. In the IDLE state, the Dispatcher waits for either another EXECUTE command or a WARM SHUTDOWN command directing it to begin shut down procedures.

VI. PROCEDURE MODULES

The modules in the task decomposition (state machine modules plus the module machine) use procedures that are packaged into separate modules. These modules are described in this section.

1. wsc_lib

This library module contains procedures from the Hewlett Packard library that are not used by the other controllers.

2. wsc_glob

This module includes data structures and procedures that are specific to the Workstation Controller, and are referenced by state machine modules as well as by procedure modules throughout the Workstation Controller program.

3. cell_glob

This module contains data structures and procedures that are specific to the Workstation Manager and the User Interface modules.

4. disp_glob

This module contains data structures and procedures that are specific to the Equipment Dispatcher modules.

5. net_trans

In the Inspection Workstation, all inter-workstation controller communication passes through the Workstation Controller. This module is used to define and manage the pass through communication mailboxes used by the workstation controllers.

VII. INTERFACE TO SUBORDINATE CONTROLLERS

1. MODULES THAT INTERFACE TO CONTROLLERS

With the current configuration there are two equipment dispatcher modules: the Inspection Robot Controller Dispatcher (irc_disp) and the Coordinate Measuring Machine Dispatcher (cmm_disp) modules.

2. DETAILS OF THE CURRENT IMPLEMENTATION

The details of the Dispatchers' implementation was previously discussed in the task decomposition section.

3. CHANGES REQUIRED FOR CONTROLLER SUBSTITUTION

The architecture of each of the equipment controllers is essentially the same. Therefore, when a new piece of equipment, along with its respective controller, is added to the workstation, there are no modifications required in the Workstation controller as long as the new equipment adopts the standard AMRF controller architecture and communication protocol.

VIII. INITIALIZATION AND SHUT DOWN

According to the UVA system model, there are two start up states and two shut down states. Refer to the IWS operation manual for the exact start up and shut down procedures.

1. START UP

The two start up states are SYNCHRONIZE WAIT and WARM SHUTDOWN. The start up transition goes from SYNCHRONIZE WAIT to WARM SHUTDOWN after receiving a SYNCHRONIZE command, and from WARM SHUTDOWN to READY state after receiving a WARM STARTUP command.

2. SHUT DOWN

The two shut down states are WARM SHUTDOWN and COLD SHUTDOWN. The shut down transition goes from a READY state to WARM SHUTDOWN after receiving a WARM SHUTDOWN command, and from WARM SHUTDOWN to COLD SHUTDOWN state after receiving a COLD SHUTDOWN command.

IX. ERROR HANDLING

All error handling consists of error detection and then transition to a COLD SHUTDOWN state. There is no way to recover from the COLD SHUTDOWN state; therefore, all errors cause the system to come to a halt.

1. PROCESS PLAN PARSER ERROR

The Production Manager module is in charge of retrieving the Process Plan and assembling the operation task list. Process Plan Parser error occurs when the Production Manager is reading the report and the format of the Process Plan is incorrect. The Process Plan is either retrieved from the IMDAS in remote data mode or from a data file if in local data mode. This error will not appear when working in local data mode.

2. DATA SERVER ERROR

The Data Server only detects errors and does not attempt to handle the error. The error status is returned to the calling module for error handling.

2.1. File Not Found

This error occurs if you are operating in local data mode and are trying to access a data file and it does not exist. The Data Server will signal an error.

2.2. IMDAS Error

This error occurs if you are operating in remote data mode and the IMDAS responds with an error status.

3. EQUIPMENT CONTROLLER ERROR

This error occurs when one of the equipment controllers respond with an error status.

X. USER INTERFACE

1. EXTRA MODULES REQUIRED FOR TESTING

1.1. user_wsc

This module is necessary when the Inspection Workstation is operated in stand-alone mode. Using this module, the user can issue commands to the Workstation Controller.

1.2. wsc_irc

This module is used to test the Workstation Controller without requiring the Inspection Robot Controller to be connected.

1.3. wsc_cmm

This module is used to test the Workstation Controller without requiring the Coordinate Measuring Machine Controller to be connected.

2. USER COMMANDS

There are two types of commands that can be issued to the WSC: transition commands and work order commands. The transition commands used to start up the WSC are SYNCHRONIZE and WARM STARTUP. The commands to shut down the WSC are WARM SHUTDOWN and COLD SHUTDOWN. There are three work orders that can be sent to the WSC: RECEIVE TRAY, INSPECT LOT, and SHIP TRAY.

3. OPERATING OPTIONS

The user can set the WSC operating options as well as send commands. There are various operating options that can be chosen when running the WSC. These options are detailed in the Operations Manual for the Inspection Workstation. The most important options are indefinite operation of a work order and enabling the Workstation Status display to monitor the Workstation operation.

XI. FUTURE PLANS

1. SOFTWARE DEVELOPMENT

1.1. Automatic Task Scheduling

An important requisite of the Hierarchical Control Strategy is that each module must be able to make planning decisions concerning the order in which to perform its tasks. At the Inspection Workstation, scheduling is necessary at the Workstation Controller level to organize the sequence of equipment inspection work orders. As mentioned above, in the present implementation the equipment level work orders are issued according to the preset order defined when the process plan was developed offline.

One possible solution to the planning requirement is to imbed an Expert System within the control structure so that decisions can be made dynamically and can be modified when more knowledge is gained about the operation. With an Expert System to supervise the task management, the operation task list, which is currently assembled in the Production Manager, would contain only high level directives such as INSPECT PART with arguments indicating the location of inspection, the duration of the inspection, and the name of the inspection plan to be used. The logic of this is to relieve the Cell Controller from having the need for knowledge of how a Workstation performs its tasks which is sub-optimal for a variety of reasons.

Therefore, in the new system, the scheduling would be a two step process. The first step would be to break down each of the high level directives into their logically connected components. For example, the INSPECT PART (at CMM) order first requires a TRANSFER command to the robot to get the part in question to the CMM, a LOAD DATA command to the CMM to load the mandatory data, an INSPECT PART command to perform the inspection on the part, and finally, a TRANSFER command to return the part to wherever it needs to go next.

To create this basic task list, the Expert System would make use of knowledge about the current state of the Workstation configuration, which would be represented as facts in its global database, and decomposition rules, represented as production rules, which would dictate how the process plan is to be decomposed. Subsequently, the second step would fill in the TRANSFER information, which is only known at run time, and would make the decisions about which task is to be performed next.

The Workstation Controller hierarchy will be modified to implement the new scheduling system. It would still be necessary to have a Cell interface module such as the Workstation Manager module of the current implementation. The first task breakdown step would be performed by the Task Manager module. This module would retrieve the necessary data from the AMRF database, create the logical operation task list, issue the command to EXECUTE to the Dispatcher modules, and monitor the Dispatchers' operation. The second step would be performed by the individual equipment Dispatcher modules.

1.2. Error Recovery

Another critical use for an Expert System is error recovery. Currently, the Inspection Workstation does not perform error recovery when a fault is detected. An Expert System could be used to diagnose the error and provide the means to recover from it. Again, the Expert System would make use of the Workstation configuration and the current state of the Workstation, and error recovery rules which can be updated when more knowledge is gained.

1.3. Multiple Work Orders Per Cell Command

In the current implementation, only one work order is accepted per cell command. In the future, the necessary cell command processing will be managed by using a data-driven rule-based approach.

1.4. Inspection Results Reported To AMRF Database (IMDAS)

Currently, the only inspection decision is whether or not the part met the specified tolerances. In the future it is intended that the inspection data will be fed back into the AMRF database so that it can be used by other workstations to increase manufacturing efficiency and possibly for statistical control.

2. NEW HARDWARE

No new hardware is expected to be purchased in the near future for the Workstation Controller.

3. PROBLEM AREAS

Problems exist in the development of a Process Plan. Care must be taken to prevent starting a task before a logical or physical precedence is met. A logical precedence, for example, is that a TRANSFER must be completed before an INSPECT PART can start. A physical precedence for example is issuing a TRANSFER (from tray) before that part is there to be transferred. If and when a new Process Plan is created, it must be tested carefully before automated operation is allowed.

APPENDICES

A. IWS DOCUMENTATION LIST

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3. H. T. Moncarz and T. H. Hopp, Implementation of the CMM Controller, to be published as an NBSIR.

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6. S. A. Osella, Implementation of the Inspection Workstation Controller, NBSIR 88-3819, August, 1988.

7. J. Zimmerman, Inventory of Equipment in the Inspection Workstation, NBSIR 88-3775, May 5, 1988.

8. H. T. Moncarz, S. A. Osella, B. Borchardt, and R. Veale, Operations Manual for the Inspection Workstation, NBSIR 88-3766, April 21, 1988.

9. J. Zimmerman, Recommended Technical Specifications for Procurement of Commercially Available Systems for the Inspection Workstation, NBSIR 88-3779, 1988.

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C. GLOSSARY (and abbreviations)

ADI
: Abbreviation for the Automatic Dial Indicator.

automatic dial indicator
: Instrument used to measure the distance that a spring mounted stem is depressed.

CMM
: Abbreviation for the Coordinate Measuring Machine.

CMMC
: Abbreviation for the CMM Controller.

controller
: Supervises the operation of a mechanism, another controller, or both.

coordinate measuring machine
: Machine used to measure the dimensions of a part.

ecs
: Abbreviation for the execution control system.

execution control system
: Computer program that runs on each controller computer and implements the AMRF design principles. This program loads and executes those modules which determine which controller is actually being run.

inspection workstation
: AMRF workstation that inspects parts for dimensional tolerance and surface finish.

IRC
: Abbreviation for the Inspection Robot Controller.

IWS
: Abbreviation for the Inspection Workstation.

logical architecture
: Specifies the direction of commands and statuses between controllers and between controllers and equipment.

physical architecture
: Specifies the physical connections among the controllers and equipment.

ready state
: The state in which a controller is ready to accept work order commands. This is the normal state of the controller during its operation.

SRI
: Abbreviation for the Surface Roughness Instrument.

state machine
: Software control unit with outputs dependent on inputs to it plus its internal state. This is the building block for the IWS control software.

surface roughness instrument
: Machine that measures the optical scattering off the surface of a part that can be correlated with its surface roughness.

transition commands
: Commands used to transfer the IWS to a new state (specified by the UVA protocol).

UVA Protocol
: Model, proposed by research group from the University of Virginia and adopted by the AMRF, that specifies the start up and shut down sequence for the AMRF as a whole as well as every controller within the AMRF.

work element
: The part of the work order command that specifies what main controller function to perform.

work order commands
: A command accepted by a controller when it is in ready state, and used to perform one of its main functions (specified by the work element).

WSC
: Abbreviation for the Workstation Controller.

D. LOCAL DATA FILES

The Workstation Controller adopts the same data report format used by the AMRF Database reports. Therefore, refer to the Control-Database Interface document for the report format specification. The following three sections describe the local report file name convention used by the Workstation Controller.

4.1. Tray Definition

The Tray Contents reports are named by the number of sectors contained in the tray type. For a four sector tray, which is what the IWS receives, the Tray Definition report name is TRAY_DEF_4.

4.2. Tray Contents

The Tray Contents reports are identified by the Tray Container number given in the work order command issued by the Cell Controller. For the three trays of parts, the Tray Contents report file names are TRAY_510 for TRAY_510, TRAY_520 for TRAY_520, and TRAY_530 for TRAY_530.

4.3. Process Plan

The Inspection Process Plan reports are labelled by the Process Plan name given in the work order command issued by the Cell Controller. For the three trays of parts, the Process Plan report file names are IWS_IWS_1 for TRAY_510, IWS_IWS_2 for TRAY_520, and IWS_IWS_3 for TRAY_530.

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IMPLEMENTATION OF THE INSPECTION WORKSTATION CONTROLLER

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"Implementation of the Inspection Workstation Controller"

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10. SUPPLEMENTARY NOTES

☐ Document describes a computer program; SF-185, FIPS Software Summary, is attached.

11. ABSTRACT (A 200-word or less factual summary of most significant information. If document includes a significant bibliography or literature survey, mention it here)

This document describes the implementation of the Inspection Workstation Controller (WSC). The WSC is a program which is designed to supervise the equipment controllers of the Inspection Workstation. The WSC uses a data driven, hierarchical task decomposition control strategy and incorporates the University of Virginia model for system initialization, restart, and shutdown. The WSC is comprised of a number of Finite State Machine Modules each responsible for a particular aspect of the control process.

12. KEY WORDS (Six to twelve entries; alphabetical order; capitalize only proper names; and separate key words by semicolons)

AMRF; IWS; Inspection Workstation; Hierarchical Control

13. AVAILABILITY

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